STRUCTURE of tree crops and agroforestry systems

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From monospecific tree crops

Eucalyptus plantations (Brazil)
with various structures...

Fruit orchards, olive and vineyards (France)

Quickbird- 0.7m
...to diverse agroforestry systems

Association of trees of different species and trees with other crops
in a large range of complexity!

Coffee groves with shading trees (Costa-Rica)

*Quickbird* - 0.5m
Plot structure characterization

The intraplot structure analysis allows:
- identification and segmentation of tree plots
- classification of plantation types depending on their complexity level
- identification and inventory of the tree diversity
- biomass estimation, production evaluation
- characterization of the cropping system
- characterization of the biophysical status of the crop

In the aim of:
1. understanding the crop functioning
2. evaluating its agronomical potentials

VHSR remote sensing gives some tools to extract different indicators characterizing the intraplot structure of tree crops and agroforestry systems
Structure indicators estimation

- Tree mapping
  - < Species > or tree type
    - Crown shape
      - Crown delimitation
      - Crown location
        - Crown size
          - Tree spectral signature
            - Information derived from the image
  - Intraplot structure
    - Distribution/organization of the different tree types
      - Relative cover fractions
        - Characterization of the canopy different components (LAI, distribution, coverage ratio, density, porosity...)

TETIS
Tree-crops accurate structure-based classification

Different types of orchards in the South of France
Different types of orchards in the South of France

Method: SVM classifier on Fourier parameters, texture indices, and NDVI
Intra-plot shading distribution

Method: multiscale textural analysis of panchro image

1. Ikonos image (1m/pix)
2- Tree identification
3- Shading-level estimation

Shaded coffee plantation in Uganda

100m

Coffee trees
Other trees

Sunlight
Sparse shadow
Dense shadow

Other trees
Method of detection: marked point processes (developed by INRIA)

\[ \text{a tree} = \text{a position (x,y) + a radius (r)} \]
Crown delimitation

Eucalyptus plantations at early growth stages in Brazil

Method of detection: marked point processes (developed by INRIA)

\[ \text{a tree} = \text{a position } (x, y) + \text{a radius } (r) \]

* a study plot in May
* in August

Results: comparison to field-measured positions and radius:

- good tree presence/absence detection: **93% of good detection**
- good position accuracy: **~70 cm precision**
- high uncertainty on radius estimations: **~70 cm (i.e. 30%)**
LAI at the tree scale

Oil palm trees (Quickbird)

LAI of digitalized trees

2.5m-Pixel LAI

9m-Upscaled-pixel LAI

Calibration of LAI-NDVI relationship based on the field LAI measurements at tree scale
LAI of agroforestry systems

Coffee groove with shading trees in Costa-Rica

1. LAI Field measurements (LAI-2000 transects)
2. Calibration of LAI-NDVI relationship based on the field measurements of transect values and NDVI distribution

\[
LAI_{HR} = \max(0; \frac{-1.557}{\ln(NDVI_{HR})} - 2.778)
\]

3. Application of the LAI-NDVI relationship to the WV2 MS image - resolution LAI map (RMSE=0.44)
Perspectives

• Integrate the maximum of information that could be included in the data, like using simultaneously radiometric and textural attributes.

• Test new directions for improving results and reach new indicators/products (eg. SVM, waveletts, ???)

• Give more generic power to the methods and tools

• Enlarge the range of applications to more complex agroforestry structures

• Integrate the products in functionning, understanding and characterization models of these systems, especially in the aim of evalutating their diverse products and services.
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